NEW SCHEME FOR REGION APPROXIMATION AND CODING WITH SHAPE INDEPENDENT TRANSFORM

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ABSTRACT:

Our approach to image region approximation offers a complete scheme consisting from few steps. The original image is segmented using an unsupervised colour – texture regions segmentation method. Following polygonal approximation of created regions causes the region boundaries degradation. This approximation has not any important influence to the image quality and enables increasing of code efficiency. Especially for very low bit rates image coding we achieved better values of objective criteria (PSNR). For texture approximation we use the 2D shape independent orthogonal transform (DCT II.). The encoding and decoding of polygons is very efficient, because we need to store only the endpoints of them. The texture is coded with modified code similar to JPEG arithmetic code.

1. INTRODUCTION

Lately, great concern in image processing is devoted to region oriented methods. Region oriented image representation offers several advantages over block-oriented approach, e.g. adaptation to the local image characteristics. New algorithms are necessary for image coding, if we work on arbitrarily shaped image regions, called segments, instead on rectangular blocks. The original approach for the coding of arbitrarily shaped image segments based on a generalized orthogonal transform was discussed in (Gilge, M., Engelhardt, T., Mehlan, R., 1989). Application scheme with cosine transform is proposed in (Kaup,A., Aach,T., 1998). In this article, there are region boundaries found using gradient method. The boundaries are approximated by polygonal lines, e.g. (Eden, M., Kocher, M, 1995) and the texture inside each region is approximated using basis functions of 2D shape independent orthogonal transform defined on the rectangle circumscribing the given image segment. Each segment is approximated by the same number of basis functions. The results are linearly quantized and coded with variable-length code. In our contribution, we developed a new scheme for the approximation and coding.

2. IMAGE SEGMENTATION

To partition the image we used an unsupervised segmentation method for colour –texture regions (Deng, Y. Manjunath, B., S., 2001). The segments are found in a few steps. First, colours in the image are quantized to several representative classes and image pixels are then replaced by their corresponding colour class labels. In this way we obtain a class – map. In the class – map so called J-values are solved from local neighbourhood of a pixel. These J-values correspond to the minimum variation of texture in image regions. The larger the J-value is, the more likely the corresponding pixel is near a region boundary. Finally, a region growing and merging method is applied to the image of J-values to obtain the final segmentation.
The result of segmentation can be, an image, where each region is defined by its unique gray value.

3. POLYGONAL APPROXIMATIONS OF THE REGIONS

First, the boundaries of all input regions are to be found. The boundary point is each point, its gray value is equal to region gray value, but the gray value of at least one of neighboring pixels differs from the region gray value. To find the boundaries, 8-directional algorithm based on LML (left-most-looking) rule used (Gonzalez, C., C, Wintz, P., 1987). Now each segment is described by own boundary, so that bettween neighboring segments there are in all cases two paralel boundaries, one for each segment.
These doubled boundaries between neighboring segmentsare reduced.It is pointless to encode both of them. .
The boundaries of the segments are simply approximated with polygons.

4. TEXTURE APPROXIMATION

The texture inside each region is again approximated using basis functions of 2D shape independent orthogonal discrete cosine transform II (Kaup,A., Aach,T., 1998). Unlike previous method in our approach the number of basis functions is derived from approximation quality requirement. the approximation come The approximation come up PSNR 40-50 dB for each segment with possibility to interactively approve quality of approximation or use further, more exact, approximation. The results are normalized for human visual system with respect to spectral elements, that are most important for human vision. Then the coefficients are linearly quantized. It results in optimal number of basis functions utilized individually for each region. The number is optimized with respect to mean square error.

5. CODING

5.1 Coding of the polygons

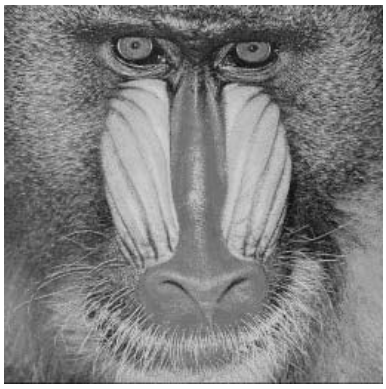
The polygonal approximation supports additional bit-rate reduction, while there is no need to encode all directions between the endpoints of a boundary segment. Storing only several chosen points between two endpoints is sufficient for further image decoding . Creating the line between two points of a boundary segment in the decoder is based on Bresenham algorithm (Ferko, A., Ružický, E., 1995). Then the boundary is defined without further coding. Then, the whole data stream consisting of all encoded boundaries is encoded once more, using the modified Huffman code with DPCM.

5.2 Coding of the textures

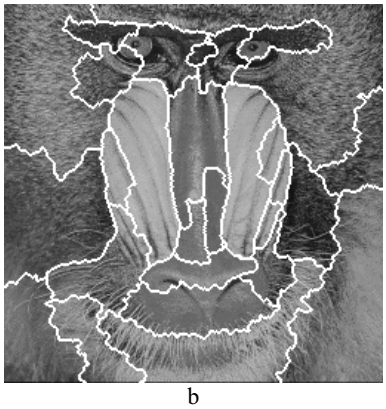
Final step of the scheme is binary arithmetic code of the quantized basis functions, that approximate the region textures. The code is modified for this type of sequence of numbers. Resulting code is very similar to JPEG arithmetic code.

6. CONCLUSION

The method is very sensitive to the quality of segmentation, number of regions, their sizes and degree (depth) of the approximation. Especially, big size of the region increases the coding time rapidly. For greater number of regions the method is not efficient with respect to the bit rate. In comparison with that, boundary degradation has a very small effect on the quality of the resulting image, but is very important for increasing the code efficiency. The advantage of this approach in the region (surface) approximation compared to the block based approach is illustrated on Figures.

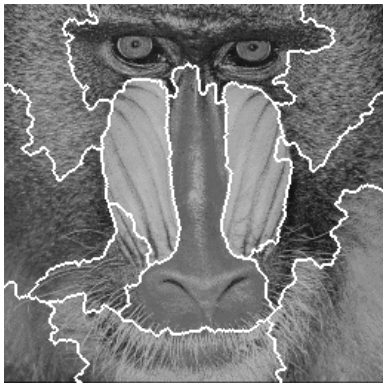


a



b

c



d

e

Figure 1. Image baboon, 256x256 pixels, 256 gray levels: a) original, b) segmented image **a** with JSEG (30 shapes), c) polygonal approximation of **a**, d) segmented image **b** with JSEG (12 shapes), e) polygonal approximation of **b**

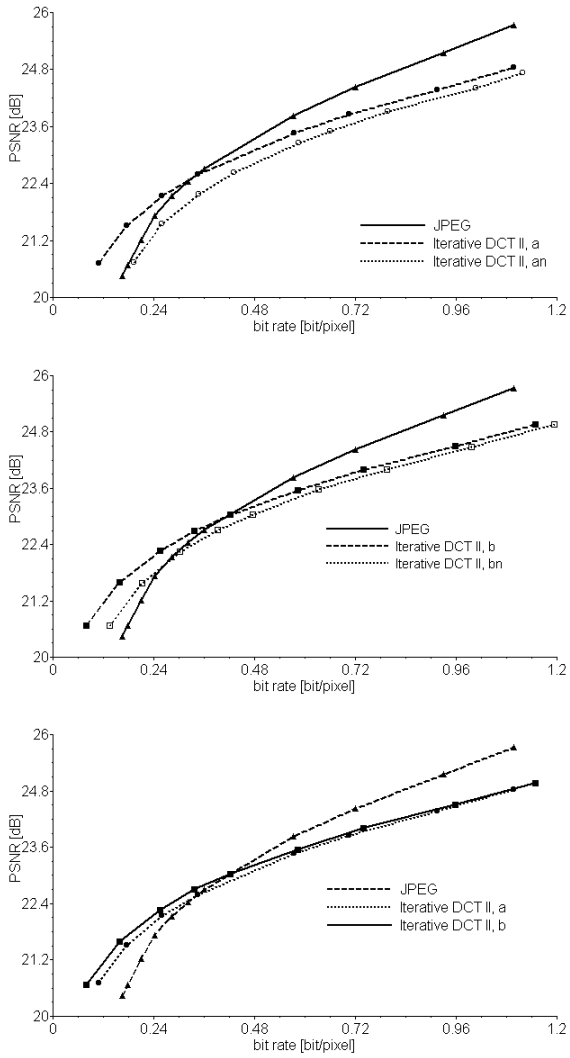


Figure 2. Baboon: diagrams of PSNR performance for various segmentations and polygonal approximations of baboon (DCT II texture approximation):
a – segmentation and polygonal approximation (Fig. 1 c), 610 bytes per image,
an – segmentation without polygonal approximation (Fig. 1 b), 1285 bytes per image,
b – segmentation and polygonal approximation (Fig. 1 e), 363 bytes per image,
bn – segmentation without polygonal approximation (Fig. 1 d), 804 bytes per image,
JPEG – JPEG coding (Corel PHOTO – PAINT 9).

a b c

Figure 3. Image baboon: a) resulting image of JPEG approach (0,361 bit/pixel, PSNR 22,71 dB), b) reconstructed image processed by proposed method **a** (0,346 bit/pixel, PSNR 22,59 dB), c) reconstructed image processed by proposed method **b** (0,337 bit/pixel, PSNR 22,70 dB)

a

b

c

d

e

Figure 4. Image Lena 256x256 pixels, 256 gray levels: a) original, b) segmented image with JSEG (11 shapes), c) polygonal approximation, d) resulting image of JPEG approach (0,265 bit/pixel, PSNR 26,58 dB), e) reconstructed image processed by proposed method (0,258 bit/pixel, PSNR 26,77 dB

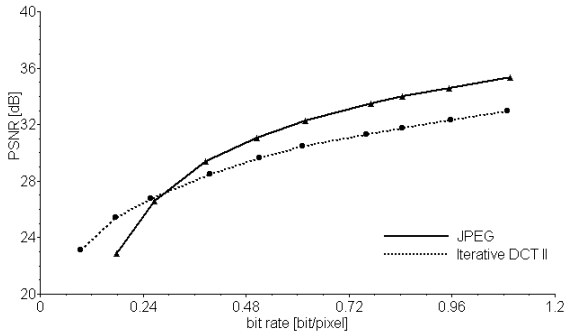


Figure 5. Lena: diagram of PSNR performance (polygonal approximation 348 bytes per image)

7. REFERENCES

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